

20. Young, A. T.: Microcellular foams via phase separation, *J. Vac. Sci. Technol.*, A4: 1126-1133, 1985.
21. Kabra, B. G. and Gehrke, S. H.: Synthesis of fast response, temperature-sensitive poly(N-isopropylacrylamide) gel, *Polymer Communications*, 32: 322-323, 1991.
22. Yan, Q. and Hoffman, A. S.: Synthesis of macroporous hydrogels with rapid swelling and deswelling properties for delivery of macromolecules, *Polymer Communications*, 36: 887-889, 1995.
23. Wu, X. S., Hoffman, A. S., and Yager, P.: Synthesis and characterization of thermally reversible macroporous poly (N-isopropylacrylamide) hydrogels, *Journal of Polymer Science: Part A: Polymer Chemistry*, 30: 2121-2129, 1992.
24. Kabra, B. G. and Gehrke, S. H.: Rate-limiting steps for solvent sorption and desorption by microporous stimuli-sensitive absorbent gels, in *Superabsorbent Polymers*, American Chemical Society, Washington, D.C., 1994, 76-86.
25. Rezai, E., Lahrman, F. H., and Iwasaki, T.: Porous, absorbent macrostructures of bonded absorbent particles surface crosslinked with cationic amino-epichlorohydrin adducts, U.S. Pat. No. 5,324,561, 1994.
26. Hartley, F. D., Cross, M. M., and Lord, F. W.: The mechanism of polyurethane foam formation, in *Advances in Polyurethane Technology*, John Wiley and Sons Inc., New York, N.Y., 1968, 139.
27. Klemperer, D. and Frisch, K. C. *Polymeric Foams*, Hanser Publishers, New York, 1991, Pages.
28. Gordon, A. H. *Electrophoresis of proteins in polyacrylamide and starch gels*, American Elsevier Publishing Company, Inc., New York, N.Y., 1971, Pages.
29. Arshady, R.: Albumin microspheres and microcapsules: methodology of manufacturing techniques, *Journal of Controlled Release*, 14: 111-131, 1990.
30. Tanaka, T. and Fillmore, D. J.: Kinetics of swelling of gels, *J. Chem. Phys.*, 70: 1214-1218, 1979.
31. Gehrke, S. H.: Synthesis, equilibrium swelling, kinetics permeability and applications of environmentally responsive gels, in *Responsive Gels: Volume Transitions II*, Springer-Verlag, New York, 1993, 81-144.
32. Knack, I. and Beckert, W.: Superabsorbent fibre flocks, methods for their production and application, U.S. Pat. No. 5,002,814 (1991).
33. Takeda, H. and Taniguchi, Y.: Production process for highly water absorbable polymer, U.S. Pat. No. 4,525,527 (1985).
34. Shutov, F. A.: Cellular structure and properties of foamed polymers, in *Polymeric Foams*, Hanser Publishers, New York, 1991, 34-35.
35. Kellenberger, S. R., Shih-Schroeder, W.-H., and Wisneski, A. J.: Absorbent structure, U.S. Pat. No. 5,149,335 (1992).
36. Holly, F. J. and Refojo, M. F.: Water wettability of hydrogels, in *Hydrogels for Medical and Related Applications*, American Chemical Society, Washington D.C., 1976, 252-266.
37. Ratner, B. D.: Hydrogel surfaces, in *Hydrogels in Medicine and Pharmacy: Volume I. Fundamentals*, CRC Press, Inc., Boca Raton, Fla., 1986, 85-94.
38. Kanig, J. L. and Rudnic, E. M.: The mechanisms of disintegrant action, *Pharmaceutical Technology*, April: 50-63, 1984.
39. Gissinger, D. and Stamm, A.: A comparative evaluation of the properties of some tablet disintegrants, *Drug Development and Industrial Pharmacy*, 6: 511-536, 1980.

40. DesMarais, T. A. and Stone, K. J.: Method for hydrophilizing absorbent foam materials using sorbitan monolaurate, U.S. Pat. No. 5,292,777, 1994.
 41. Anderson, D. M. and Ström, P.: Polymerized lyotropic liquid crystals as contact lens materials, *Physica A*, 176: 151-167, 1991.
- What is claimed is:
1. A hydrogel composite comprising an interpenetrating network of a crosslinked polymer and particles of a disintegrant, wherein:
 - said crosslinked polymer is formed from at least one ethylenically-unsaturated monomer and a multi-olefinic crosslinking agent; and
 - said disintegrant is at least one of (i) a crosslinked natural or synthetic polyelectrolyte, (ii) a crosslinked neutral hydrophilic polymer, (iii) a non-crosslinked natural or synthetic polyelectrolyte having a particulate shape, (iv) a non-crosslinked neutral hydrophilic polymer having a particulate shape, or (v) a porous inorganic material that provides wicking by capillary forces.
 2. The hydrogel composite of claim 1, wherein the ratio of disintegrant to polymer is in the range of 1:100 to 100:100.
 3. The hydrogel composite of claim 1, wherein the ratio of multi-olefinic crosslinking agent to monomer is in the range of 0.01:100 to 10:100.
 4. The hydrogel composite of claim 1, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of (meth)acrylic acid, salts of (meth)acrylic acid, esters of (meth)acrylic acid, salts and acids of esters of (meth)acrylic acid, amides of (meth)acrylic acid, N-alkyl amides of (meth)acrylic acid, salts and acids of N-alkyl amides of (meth)acrylic acid, N-vinyl pyrrolidinone, acrylamide, acrylamide derivatives, methacrylamide, methacrylamide derivatives, and mixtures thereof.
 5. The hydrogel composite of claim 1, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of acrylamide (AM), N-isopropylacrylamide (NIPAM), 2-hydroxyethyl methacrylate (HEMA), 2-hydroxypropyl methacrylate (HPMA), N-vinyl pyrrolidinone (VP), acrylic acid (AA), 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS), 3-sulfopropyl acrylate potassium salt (SPAK), 2-(acryloyloxy)ethyltrimethyl-ammonium methyl sulfate (ATMS), inorganic salts thereof, and mixtures thereof.
 6. The hydrogel composite of claim 1, wherein the crosslinking agent is selected from the group consisting of N,N'-methylenebisacrylamide, ethylene glycol di(meth)acrylate, piperazine diacrylamide, glutaraldehyde, epichlorohydrin, crosslinking agents containing 1,2-diol structures, crosslinking agents containing functionalized peptides, and crosslinking agents containing proteins.
 7. The hydrogel composite of claim 1, wherein the particles of disintegrant are selected from the group consisting of crosslinked sodium carboxymethylcellulose, crosslinked sodium starch glycolate, crosslinked sodium carboxymethyl starch, crosslinked dextran sulfate, crosslinked chitosan, crosslinked hyaluronic acid, crosslinked sodium alginate, crosslinked pectinic acid, crosslinked deoxyribonucleic acids, crosslinked ribonucleic acid, crosslinked gelatin, crosslinked albumin, polyacrolein potassium, sodium glycine carbonate, crosslinked poly(acrylic acid), crosslinked poly(styrene sulfonate), crosslinked poly(aspartic acid), crosslinked polylysine, crosslinked polyvinylpyrrolidone, crosslinked ultramylopectin, crosslinked poly(ethylene glycol), crosslinked neutral cellulose derivatives, microcrystalline cellulose, powdered cellulose, cellulose fiber, and crosslinked starch.

8. The hydrogel composite of claim 1, which has a swelling ratio in the range of 2 to 1,000.

9. The hydrogel composite of claim 1, which has a compression modulus in the range of 0.01 to 5 kg/cm².

10. The hydrogel composite of claim 1, which has a swelling time in the range of 10 seconds to 10 hours for a sample having a size in the range of 0.01 cm³ and larger.

11. A superporous hydrogel composite having a superporous pore structure comprising an interpenetrating network of a crosslinked polymer and particles of a disintegrant, wherein:

said crosslinked polymer is formed from at least one ethylenically-unsaturated monomer and a multi-olefinic crosslinking agent; and

said disintegrant is at least one of (i) a crosslinked natural or synthetic polyelectrolyte, (ii) a crosslinked neutral hydrophilic polymer, (iii) a non-crosslinked natural or synthetic polyelectrolyte having a particulate shape, (iv) a non-crosslinked neutral hydrophilic polymer having a particulate shape, or (v) a porous inorganic material that provides wicking by capillary forces.

12. The superporous hydrogel composite of claim 11, wherein the ratio of disintegrant to polymer is in the range of 1:100 to 100:100.

13. The superporous hydrogel composite of claim 11, wherein the ratio of multi-olefinic crosslinking agent to monomer is in the range of 0.01:100 to 10:100.

14. The superporous hydrogel composite of claim 11, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of (meth)acrylic acid, salts of (meth)acrylic acid, esters of (meth)acrylic acid, salts and acids of esters of (meth)acrylic acid, amides of (meth)acrylic acid, N-alkyl amides of (meth)acrylic acid, salts and acids of N-alkyl amides of (meth)acrylic acid, N-vinyl pyrrolidinone, acrylamide, acrylamide derivatives, methacrylamide, methacrylamide derivatives, and mixtures thereof.

15. The superporous hydrogel composite of claim 11, wherein the at least one ethylenically-unsaturated monomer is selected from the group consisting of acrylamide (AM), N-isopropylacrylamide (NIPAM), 2-hydroxyethyl methacrylate (HEMA), 2-hydroxypropyl methacrylate (HPMA), N-vinyl pyrrolidinone (VP), acrylic acid (AA), 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS), 3-sulfopropyl acrylate potassium salt (SPAK), 2-(acryloyloxy)ethyltrimethyl-ammonium methyl sulfate (ATMS), inorganic salts thereof, and mixtures thereof.

16. The superporous hydrogel composite of claim 11, wherein the crosslinking agent is selected from the group consisting of N,N'-methylene-bisacrylamide, ethylene glycol di(meth)acrylate, piperazine diacrylamide, glutaraldehyde, epichlorohydrin, crosslinking agents containing 1,2-diol structures, crosslinking agents containing functionalized peptides, and crosslinking agents containing proteins.

17. The superporous hydrogel composite of claim 11, wherein the particles of disintegrant are selected from the group consisting of crosslinked sodium carboxymethylcellulose, crosslinked sodium starch glycolate, crosslinked sodium carboxymethyl starch, crosslinked dextran sulfate, crosslinked chitosan, crosslinked hyaluronic acid, crosslinked sodium alginate, crosslinked pectinic acid, crosslinked deoxyribonucleic acids, crosslinked ribonucleic acid, crosslinked gelatin, crosslinked albumin, polyacrolein potassium, sodium glycine carbonate, crosslinked poly(acrylic acid), crosslinked poly(styrene sulfonate), crosslinked poly(aspartic acid),

crosslinked polylysine, crosslinked polyvinylpyrrolidone, crosslinked ultramylopectin, crosslinked poly(ethylene glycol), crosslinked neutral cellulose derivatives, microcrystalline cellulose, powdered cellulose, cellulose fiber, and crosslinked starch.

18. The superporous hydrogel composite of claim 11, which has a swelling ratio in the range of 5 to 5000.

19. The superporous hydrogel composite of claim 11, which has a swelling time in the range of 1 second to 1 hour for a sample having a size in the range of 0.01 cm³ and larger.

20. A superporous hydrogel composite comprising an interpenetrating network of a crosslinked polymer and particles of a disintegrant, said composite prepared by a process comprising:

combining at least one ethylenically-unsaturated monomer, a multi-olefinic crosslinking agent, particles of a disintegrant, and a blowing agent to form an admixture thereof; and

subjecting said admixture to polymerization and foaming conditions to form said superporous hydrogel composite,

wherein said disintegrant is at least one of (i) a crosslinked natural or synthetic polyelectrolyte, (ii) a crosslinked neutral hydrophilic polymer, (iii) a non-crosslinked natural or synthetic polyelectrolyte having a particulate shape, (iv) a non-crosslinked neutral hydrophilic polymer having a particulate shape, or (v) a porous inorganic material that provides wicking by capillary forces.

21. The superporous hydrogel composite of claim 20, which has an average pore size in the range of 10 μ m to 3,000 μ m.

22. The superporous hydrogel composite of claim 20, which has an average pore size in the range of 50 μ m to 1,000 μ m.

23. The superporous hydrogel composite of claim 20, which has an average pore size in the range of 100 μ m to 600 μ m.

24. The superporous hydrogel composite of claim 20, wherein the ratio of disintegrant to polymer is in the range of 1:100 to 100:100.

25. The superporous hydrogel composite of claim 20, wherein the ratio of crosslinking agent to monomer is in the range of 0.01:100 to 10:100.

26. The superporous hydrogel composite of claim 20, wherein the blowing agent is NaHCO₃, Na₂CO₃, CaCO₃, or gas bubbles introduced from an external source.

27. The superporous hydrogel composite of claim 20, wherein the swelling ratio is in the range of 5 to 5,000.

28. The superporous hydrogel composite of claim 20, wherein the swelling time is in the range of 1 second to 1 hour.

29. The superporous hydrogel composite produced by drying the composite formed in claim 20 by air-drying or by replacing water in the composite with an organic solvent followed by air drying.

30. The superporous hydrogel composite of claim 29, which upon drying exhibits elastic properties of compression, extension, and folding without breaking.

31. The superporous hydrogel composite produced by drying the superporous hydrogel composite formed in claim 20 by freeze-drying after partial swelling or equilibrium swelling in aqueous solution.

32. The superporous hydrogel composite of claim 31, which upon drying exhibits elastic properties of compression, extension, and folding without breaking.

43

33. A method of forming a hydrogel composite comprising:

combining at least one ethylenically-unsaturated monomer, a multi-olefinic crosslinking agent, and particles of a disintegrant, to form an admixture thereof; and

subjecting the admixture to polymerization conditions to form said hydrogel composite.

34. The method of claim 33, further combining water with said admixture prior to subjecting the admixture to said polymerization conditions.

35. The method of claim 33, further combining a polymerization initiator with said admixture prior to subjecting the admixture to said polymerization conditions.

36. A method of forming a superporous hydrogel composite comprising:

combining at least one ethylenically-unsaturated monomer, a multi-olefinic crosslinking agent, particles of a disintegrant, and a blowing agent, to form an admixture thereof; and

subjecting the admixture to polymerization and foaming conditions to form said superporous hydrogel composite.

37. The method of claim 36, wherein said at least one ethylenically-unsaturated monomer, multi-olefinic crosslinking agent, and particles of a disintegrant are combined prior to combining the blowing agent therewith.

38. The method of claim 36, further combining water with said admixture prior to subjecting the admixture to said polymerization and foaming conditions.

39. The method of claim 36, further combining a foam stabilizing agent with said admixture prior to subjecting the admixture to said polymerization and foaming conditions.

40. The method of claim 36, further combining a polymerization initiator with said admixture prior to subjecting the admixture to said polymerization and foaming conditions.

* * * * *

44